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Early Paleozoic tectonic evolution of the North Qinling Orogenic Belt in Central China: insights on continental deep subduction and multiphase exhumation

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New evidence suggests that: (1) The HP-UHP rocks occur as lenses or layers surrounded by gneissic rocks in the northern, central, and southern Qinling Complex, considered to have formed through continental deep subduction; They yield peak metamorphic ages in the range of ca. 511–484 Ma and retrograde metamorphic ages of ca. 470–450 Ma and ca. 430–420 Ma. These correspond to the processes of continent deep subduction and two subsequent stages of exhumation, respectively. (2) The magmatic protoliths of the HP-UHP metamorphic rocks show formation ages (843–700 Ma), geochemical characteristics, and Pb-Nd isotopic compositions similar to those of the Neoproterozoic igneous rocks of the South Qinling belt. (3) The subduction timing of Shangdan ocean (ca. 520–500 Ma) is earlier or coeval with the HP-UHP metamorphic age (ca. 500 Ma) in the NQB, whereas the subduction timing of Erlangping ocean (ca. 486–463 Ma) is about 20 Ma later than the HP-UHP metamorphic age of the HP-UHP rocks in the NQB. Consequently, continental materials were dragged down by the Shangdan oceanic lithosphere and underwent deep subduction, rather than the Erlangping oceanic lithosphere, leading to widespread HP-UHP metamorphism in the NQB. (4) The three stages of ~500 Ma, ~450 Ma and ~420 Ma magmatic activities in the North Qinling HP-UHP belt are related to deep subduction/collision, slab-breakoff and crustal thinning during post-orogenic extension. (5) The dominant ca. 500–400 Ma ages of detrital zircons from the Liuling Group of the South Qinling belt match well with those from the three stages of magmatic rocks and HP-UHP rocks in the Qinling Complex, suggesting that the early Paleozoic three stages of magmatic rocks and HP-UHP metamorphic rocks of NQB initially exhumed to the surface, eroded and were then deposited in the Liuling basin in a post-collisional extensional setting during middle to upper Devonian. (6) The sedimentary unit of Erlangping Complex formed during later Cambrian – middle Ordovician (ca. 500–480 Ma), which is possibly slightly older than the formation age of the volcanic rocks (ca. 500-460 Ma), but later than the formation time (ca. 520–500 Ma) of arc rocks in the Shangdan ophiolitic mélange. Thus, we suggest that the Erlangping Complex was developed on a back-arc basin related to the northward subduction of Shangdan Ocean during early Paleozoic. (7) Fossils records and detrital zircon age data suggest the sedimentary rock unit of the Kuangping Complex formed during early-middle Ordovician, which have similar depositional age and source to the sedimentary unit from the Erlangping Complex, indicating both of them formed near simultaneously in a similar or same back-arc setting in the early Paleozoic. (8) Detrital zircons in the sedimentary rocks of Erlangping and Kuanping complexes show a dominated age population of 0.9−1.0 Ga, which was sourced from the early Neoproterozoic granites of the Qinling Complex. This suggests that the early Neoproterozoic granites in the Qinling Complex were exhumed, eroded and the detritus accumulated in the Erlangping and Kuanping sedimentary basin (ca. 500−480 Ma), and were not subjected to the early Paleozoic continent deep subduction (ca. 500 Ma). Therefore, the Qinling Complex is a tectonic complex rather than a uniform stratigraphic unit or a Precambrian microcontinent

as previously believed, and is mainly composed of the exhumed HP-UHP metamorphic rocks, deep subduction/collision and exhumation-related magmatic rocks and the early Neoproterozoic granites together with the host rocks from the over-riding plate at an active continental margin. Comprehensively, Early Paleozoic tectonic history of the NQB includes oceanic slab subduction and formation of arc, backarc spreading, continental deep subduction, arc-continent collision, slab break off, and multi-stage exhumation of the deep subducted slab, as well as extension and thinning and associated erosion and re-deposition.